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SUMMARIZATION-INSPIRED TEMPORAL-RELATION EXTRACTION: TENSE-PAIR TEMPLATES AND TREEBANK-3 ANALYSIS

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Abstract

This document describes the information used for summarization-inspired temporal-relation extraction [Dorr and Gaasterland, 2007]. We present a set of tense/aspect extraction templates that are applied to a Penn Treebank-style analysis of the input sentence. We also present an analysis of tense-pair combinations for different temporal connectives based on a corpus analysis of complex tense structures in Treebank-3. Finally, we include analysis charts and temporal relation tables for all combinations of intervals/points for each legal BTS combinations.

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```
(S1
  (S (NP-SBJ (NP (NNP John)))
     (VP (VBD caught) (NP (PRP his) (NN plane))
       (SBAR-TMP (IN before)
         (S (NP-SBJ (NP (NNP Mary))) (VP (VBD arrived)))))))
```

Figure 1: Penn Treebank Representation of Temporally Related Matrix/Adjunct Pair

1 Introduction

This document describes the information used for summarization-inspired temporal-relation extraction [Dorr and Gaasterland, 2007].

First, we present a set of tense/aspect extraction templates that are applied to a Penn Treebank-style analysis of the input sentence (e.g., the output of parsers by [Collins, 1996] or [Charniak, 2000]). For example, a Penn Treebank-style analysis of *John caught his plane before Mary arrived* is shown in Figure 1, where the matrix clause starts with the first S and the adjunct clause begins with the SBAR-TMP node. Note that we examine only the matrix/adjunct pairs that contain an SBAR-TMP node, in an attempt to separate out temporally related clauses from those that are causally related.

Next, we present an analysis of tense-pair combinations for different temporal connectives based on a corpus analysis of complex tense structures in Treebank-3.

Finally, we include analysis charts for all combinations of intervals/points for each legal BTS combinations. Each analysis chart is associated with a more succinct temporal relation table.

2 Templates for Computing BTS from Treebank-Style Parse Trees

The Lisp variable *ts-table* provides the templates necessary for computing *tense structures* for computing the BTSs. Wildcards are indicated with question marks (?). The software that uses these templates is available at: `http://www.umiacs.umd.edu/~bonnie/CDTS-Solution`

```
(defparameter *ts-table*
  '(("UNCLASSIFIED"                    ; "Unclassified"
     ())
    ("PRESENT PROG"                    ; "Present Progressive: S,R,E"
     ((VBP AM   ) (VBG ?))
     ((VBP |'M| ) (VBG ?))
     ((VBP ARE  ) (VBG ?))
     ((VBP |'RE|) (VBG ?))
     ((VBZ IS   ) (VBG ?))
     ((VBZ |'S| ) (VBG ?)))
    ("PRES PERF"                       ; "Present Perfect: E_S,R"
     ((VBZ HAS  ) (VBN ?))
     ((VBZ |'S| ) (VBN ?))
     ((VBP HAVE ) (VBN ?))
     ((VBP |'VE|) (VBN ?)))
    ("PRESENT SIMPLE STATE"            ; "Present Simple State: S,R,E"
     ((VBP AM   ))
     ((VBP |'M| ))
     ((VBP ARE  ))
     ((VBP |'RE|))
     ((VBZ IS   ))
```

```
 ((VBZ |'S| ))
 ((MD CAN   ) (VB BE))
 ((MD CA   ) (VB BE))
 ((MD MAY   ) (VB BE))
 ((MD MUST  ) (VB BE))
 ((MD NEED  ) (VB BE))
 ((MD MIGHT ) (VB BE))
 ((MD OUGHT ) (VB BE))
 ((MD COULD ) (VB BE))
 ((MD SHOULD) (VB BE))
 ((MD WOULD ) (VB BE))
 ((MD |'D|  ) (VB BE)))
("PRESENT SIMPLE"                   ; "Present Simple: S,R,E"
 ((VBP ?    ))
 ((VBZ ?    ))
 ((MD CAN   ) (VB ?))
 ((MD CA   )  (VB ?))
 ((MD DO   )  (VB ?))
 ((MD DOES  )  (VB ?))
 ((MD MAY   ) (VB ?))
 ((MD MUST  ) (VB ?))
 ((MD NEED  ) (VB ?))
 ((MD MIGHT ) (VB ?))
 ((MD OUGHT ) (VB ?))
 ((MD COULD ) (VB ?))
 ((MD SHOULD) (VB ?))
 ((MD WOULD ) (VB ?))
 ((MD |'D|  ) (VB ?)))
;;"Past"
("PAST PROG"                        ; "Past Progressive: E,R_S"
 ((VBD WAS  ) (VBG ?))
 ((VBD WERE ) (VBG ?)))
("PAST PERF"                        ; "Past Perfect: E_R_S"
 ((VBD HAD  ) (VBN ?))
 ((VBD |'D| ) (VBN ?)))
("PAST SIMPLE STATE"                ; "Past Simple State: E,R_S"
 ((VBD WAS  ))
 ((VBD WERE ))
 ((MD COULD ) (VB BE))
 ((MD MAY   ) (VB HAVE) (VBN BEEN))
 ((MD MUST  ) (VB HAVE) (VBN BEEN))
 ((MD NEED  ) (VB HAVE) (VBN BEEN))
 ((MD MIGHT ) (VB HAVE) (VBN BEEN))
 ((MD COULD ) (VB HAVE) (VBN BEEN))
 ((MD SHOULD) (VB HAVE) (VBN BEEN))
 ((MD WOULD ) (VB HAVE) (VBN BEEN))
 ((MD |'D|  ) (VB HAVE) (VBN BEEN)))
("PAST SIMPLE"                      ; "Past Simple: E,R_S"
 ((VBD ?    ))
 ((MD DID   ) (VB ?))
 ((MD COULD ) (VB HAVE) (VBN ?))
 ((MD MAY   ) (VB HAVE) (VBN ?))
 ((MD MUST  ) (VB HAVE) (VBN ?))
 ((MD NEED  ) (VB HAVE) (VBN ?))
 ((MD MIGHT ) (VB HAVE) (VBN ?))
 ((MD COULD ) (VB HAVE) (VBN ?))
 ((MD SHOULD) (VB HAVE) (VBN ?))
 ((MD WOULD ) (VB HAVE) (VBN ?))
 ((MD |'D|  ) (VB HAVE) (VBN ?)))
;;"Future"
("FUT PROG"                         ; "Future Progressive: S_R,E"
 ((MD WILL  ) (VB BE  ) (VBG ?))
 ((MD |'LL| ) (VB BE  ) (VBG ?))
 ((MD WO    ) (VB BE  ) (VBG ?))
 ((MD SHALL ) (VB BE  ) (VBG ?)))
("FUT PERF"                         ; "Future Perfect: S_E_R"
 ((MD WILL  ) (VB HAVE) (VBN ?))
 ((MD |'LL| ) (VB HAVE) (VBN ?))
```

```
 ((MD WO    ) (VB HAVE) (VBN ?))
 ((MD SHALL ) (VB HAVE) (VBN ?)))
("FUT SIMPLE STATE"                  ; "Future Simple State: S_R,E"
 ((MD WILL  ) (VB BE  ))
 ((MD |'LL| ) (VB BE  ))
 ((MD WO    ) (VB BE  ))
 ((MD SHALL ) (VB BE  )))
("FUT SIMPLE"                        ; "Future Simple: S_R,E"
 ((MD WILL  ) (VB ?   ))
 ((MD |'LL| ) (VB ?   ))
 ((MD SHALL ) (VB ?   ))
 ((MD WO    ) (VB ?   )))
;; Gerund
("SIMPLE GERUND"                     ; "Simple Gerund: R,E"
 ((VBG ?    )))
))
```

3 Analysis of tense-pair Combinations for Different Temporal Connectives in TreeBank-3

This section contains an analysis of tense-pair combinations for different temporal connectives based on a corpus analysis of complex tense structures in Treebank-3.

3.1 Tense Pairs with Respect to Temporal Connective AFTER

Total	Matrix/Adjunct Pairs
151	[past simp]/[past simp]
35	[past simp state]/[past simp]
17	[past simp]/[past simp state]
10	[past simp state]/[past simp state]
7	[simp gerund]/[past simp], [past simp]/[past perf]
6	[past perf]/[past simp]
5	[fut simp]/[pres simp], [pres simp]/[pres simp state]
4	[pres simp state]/[pres simp state]
3	[fut simp state]/[pres simp state], [fut simp state]/[pres simp], [fut simp]/[pres simp state], [pres simp]/[pres perf], [pres simp]/[pres simp], [past perf]/[past simp state], [past simp state]/[past perf]
1	[past simp]/[simp gerund], [fut simp state]/[pres perf], [fut simp]/[pres perf], [simp gerund]/[pres perf], [simp gerund]/[pres simp state], [simp gerund]/[past perf], [simp gerund]/[simp gerund], [pres simp state]/[pres simp], [past prog]/[past perf], [past prog]/[past simp]

3.2 Tense Pairs with Respect to Temporal Connective AS

Total	Matrix/Adjunct Pairs for AS
173	[past simp]/[past simp]
58	[pres simp]/[pres simp]
21	[past simp state]/[past simp]
18	[pres simp state]/[pres simp]
15	[pres prog]/[pres simp]
14	[fut simp]/[pres simp]
10	[pres perf]/[pres simp]
9	[simp gerund]/[pres simp], [simp gerund]/[past simp]
8	[past simp]/[past prog]
6	[pres perf]/[pres perf], [pres simp]/[pres prog], [past simp]/[past simp state]
4	[pres simp state]/[pres simp state], [past prog]/[past simp], [past perf]/[past simp]
3	[fut simp state]/[pres simp]
2	[pres simp]/[pres simp state], [past simp state]/[past prog]
1	[fut prog]/[pres simp], [pres prog]/[pres prog], [fut simp]/[pres simp state], [pres simp state]/[pres prog], [pres simp state]/[pres perf], [pres simp]/[pres perf], [past prog]/[past prog], [past prog]/[past simp state], [past simp state]/[past simp state], [past simp]/[past perf]

3.3 Tense Pairs with Respect to Temporal Connective BEFORE

Total	Matrix/Adjunct Pairs for BEFORE
34	[past simp]/[past simp]
22	[pres simp]/[pres simp]
13	[past simp state]/[past simp]
10	[fut simp]/[pres simp]
9	[pres simp state]/[pres simp]
7	[pres simp]/[pres simp state], [past simp]/[past simp state]
6	[past prog]/[past simp]
5	[past perf]/[past simp], [past simp state]/[past simp state]
4	[pres prog]/[pres simp]
3	[fut simp state]/[pres simp], [pres simp state]/[pres simp state]
2	[fut simp state]/[pres simp state], [fut simp state]/[fut simp], [fut simp]/[pres simp state]
1	[simp gerund]/[pres simp], [simp gerund]/[past simp], [simp gerund]/[simp gerund], [pres perf]/[pres perf], [pres simp]/[pres perf], [past perf]/[past simp state], [past simp state]/[past perf], [past simp]/[past perf]

3.4 Tense Pairs with Respect to Temporal Connective ONCE

Total	Matrix/Adjunct Pairs for ONCE
18	[pres simp]/[pres simp]
13	[pres simp]/[pres simp state]
6	[fut simp]/[pres simp], [past simp]/[past simp]
5	[fut simp]/[pres simp state]
3	[pres simp state]/[pres simp], [past simp state]/[past simp]
2	[fut simp state]/[pres simp], [pres simp state]/[pres simp state]
1	[fut perf]/[pres simp state], [fut simp state]/[pres simp state], [simp gerund]/[pres perf], [pres simp state]/[pres perf], [past simp state]/[past simp state], [past simp]/[past simp state]

3.5 Tense Pairs with Respect to Temporal Connective SINCE

Total	Matrix/Adjunct Pairs for SINCE
5	[past simp state]/[past simp]
2	[pres perf]/[pres perf], [past simp]/[past simp state], [past simp]/[past simp]
1	[simp gerund]/[past simp], [pres simp state]/[pres perf], [pres simp state]/[pres simp state], [pres simp]/[pres simp state], [pres simp]/[pres simp], [past perf]/[past simp]

3.6 Tense Pairs with Respect to Temporal Connective UNTIL

Total	Matrix/Adjunct Pairs for UNTIL
16	[past simp]/[past simp]
9	[fut simp]/[pres simp state], [pres simp]/[pres simp]
7	[fut simp]/[pres simp]
6	[fut simp state]/[pres simp], [past simp state]/[past simp]
5	[pres simp]/[pres simp state]
3	[fut simp state]/[pres simp state], [fut simp]/[pres perf], [simp gerund]/[pres simp state], [simp gerund]/[pres simp], [pres simp state]/[pres simp state], [pres simp state]/[pres simp], [pres simp]/[pres perf], [past simp]/[past perf]
2	[pres prog]/[pres simp state], [past prog]/[past simp state], [past simp]/[past simp state]
1	[pres simp state]/[pres perf], [past prog]/[past simp], [past perf]/[past simp state], [past perf]/[past simp]

3.7 Tense Pairs with Respect to Temporal Connective WHEN

Total	Matrix/Adjunct Pairs for WHEN
254	[past simp]/[past simp]
116	[pres simp]/[pres simp]
76	[past simp state]/[past simp]
52	[past simp]/[past simp state]
54	[pres simp state]/[pres simp]
37	[pres simp]/[pres simp state]
21	[fut simp]/[pres simp]
20	[pres simp state]/[pres simp state]
19	[past simp state]/[past simp state]
14	[simp gerund]/[pres simp]
12	[pres simp]/[pres prog]
11	[pres simp]/[simp gerund]
8	[past perf]/[past simp], [past simp]/[past prog]
7	[pres simp state]/[pres prog], [past prog]/[past simp]
6	[pres prog]/[pres simp], [pres perf]/[pres simp]
5	[fut simp]/[pres simp state], [simp gerund]/[past simp], [pres simp]/[pres perf]
4	[fut simp state]/[pres simp], [simp gerund]/[pres simp state], [past perf]/[past simp state]
3	[simp gerund]/[past simp state], [past prog]/[past simp state]
2	[fut simp state]/[pres simp state], [fut simp]/[pres perf], [pres prog]/[pres simp state], [past simp state]/[past prog]
1	[past simp]/[simp gerund], [fut prog]/[pres simp], [pres prog]/[pres prog], [pres prog]/[pres perf], [simp gerund]/[pres prog], [simp gerund]/[pres perf], [simp gerund]/[simp gerund], [pres perf]/[pres perf], [pres perf]/[pres simp state], [pres simp state]/[simp gerund], [past perf]/[past prog], [past simp]/[past perf]

3.8 Tense Pairs with Respect to Temporal Connective WHILE

Total	Matrix/Adjunct Pairs for WHILE
27	[past simp]/[past simp]
16	[pres simp]/[simp gerund]
13	[past simp]/[simp gerund]
12	[past simp]/[past simp state]
11	[pres simp]/[pres simp]
7	[simp gerund]/[simp gerund]
5	[past simp]/[past prog]
4	[simp gerund]/[past simp], [pres perf]/[pres perf]
3	[simp gerund]/[pres simp], [pres perf]/[simp gerund], [pres simp]/[pres simp state], [past simp state]/[past simp]
2	[pres prog]/[pres simp], [pres prog]/[simp gerund], [pres perf]/[pres simp], [pres simp state]/[pres prog], [pres simp state]/[pres simp state], [pres simp state]/[simp gerund], [pres simp]/[pres prog], [past prog]/[past simp], [past prog]/[simp gerund], [past simp state]/[past prog], [past simp state]/[past simp state]
1	[fut simp state]/[pres simp], [fut simp]/[pres simp state], [fut simp]/[pres simp], [fut simp]/[simp gerund], [simp gerund]/[pres simp state], [simp gerund]/[past simp state], [pres perf]/[pres simp state], [pres simp state]/[pres perf], [pres simp]/[pres perf], [past perf]/[past simp state]

4 Analysis Chart for Past/Past BTS Combination

To build a full implementation of the method for extracting Allen's temporal relations, an analysis chart must be built for all combinations of intervals/points for each legal BTS combinations. The analysis charts contain combinations of verbs from different aspectual categories: state (*be angry/happy*), extended activity (*walk*), point activity (*wink*), accomplishment (*write a letter*), and achievement (*win the race*).

In addition, the progressive and simple forms are included for each verb. In producing the analysis chart, certain linguistic generalizations became apparent. In particular, we observed that the *activity*/*achievement*/*accomplishment* distinction did not affect the connecting word meanings. Thus, we were able to construct a more succinct temporal relation table for each analysis chart.

Below we include the analysis chart and temporal relation table for the past/past and future/present BTS Combination.

4.1 Analysis Chart and Temporal Relation Table for the Past/Past BTS Combination

This section includes an analysis chart and temporal relation table for the Past/Past BTS combination for *after*, *before*, and *while*, e.g., *She won the race while John wrote a letter*.

Matrix	AFTER	BEFORE	WHILE	Adjunct
Mary was winning the race *Ach, Prog:* ●—●	>	<	= o oi s d f	John was writing a letter *Acc, Prog:* ●—●
Mary was winning the race *Ach, Prog:* ●—●	oi mi f >	o m f <	″	John was winking *Act(pt), Prog:* ●—●, ●—○
John was winking *Act(pt), Prog:* ●—●, ●—○	>	<	″	Mary was winning the race *Ach, Prog:* ●—●
John was winking *Act(pt), Prog:* ●—●, ●—○	oi mi f >	o m fi <	″	Mary was walking *Act(ext), Prog:* ●—●, ●—○
Mary was winning the race *Ach, Prog:* ●—●	>	<	= o oi s d f	John wrote a letter *Acc, Simp:* ●
Mary was winning the race *Ach, Prog:* ●—●	″	″	″	John winked *Act(pt), Simp:* ●
John was winking *Act(pt), Prog:* ●—●, ●—○	″	″	″	Mary won the race *Ach, Simp:* ●
John was winking *Act(pt), Prog:* ●—●, ●—○	″	″	= oi s d f <	Mary walked *Act(ext), Simp:* ●—●
Mary was winning the race *Ach, Prog:* ●—●	oi mi f >	o m fi <	″	John was angry *State, Simp:* ●—●, ●—○
Mary was winking *Act(pt), Prog:* ●—●, ●—○	″	″	″	John was angry *State, Simp:* ●—●, ●—○
Mary won the race *Ach, Simp:* ●	>	<	= s d f fi	John was writing a letter *Acc, Prog:* ●—●
Mary won the race *Ach, Simp:* ●	oi mi f >	o m fi <	″	John was winking *Act(pt), Prog:* ●—●, ●—○
John winked *Act(pt), Simp:* ●	>	<	″	Mary was winning the race *Ach, Prog:* ●—●
John winked *Act(pt), Simp:* ●	oi mi f >	o m fi <	″	Mary was walking *Act(ext), Prog:* ●—●, ●—○
Mary won the race *Ach, Simp:* ●	>	<	= s d f fi	John wrote a letter *Acc, Simp:* ●
Mary won the race *Ach, Simp:* ●	″	″	″	John winked *Act(pt), Simp:* ●
John winked *Act(pt), Simp:* ●	″	″	″	Mary won the race *Ach, Simp:* ●
John winked *Act(pt), Simp:* ●	″	″	″	Mary walked *Act(ext), Simp:* ●—●
Mary won the race *Ach, Simp:* ●	oi mi f >	o m fi <	= s d f	John was angry *State, Simp:* ●—●, ●—○
Mary winked *Act(pt), Simp:* ●	″	″	″	John was angry *State, Simp:* ●—●, ●—○
John was angry *State, Simp:* ●—●, ●—○	>	<	= o oi s d f	Mary was winning the race *Ach, Prog:* ●—●
John was angry *State, Simp:* ●—●, ●—○	oi mi f >	o m fi <	″	Mary was walking *Act(ext), Prog:* ●—●, ●—○
John was angry *State, Simp:* ●—●, ●—○	>	<	″	Mary won the race *Ach, Simp:* ●
John was angry *State, Simp:* ●—●, ●—○	″	″	″	Mary walked *Act(ext), Simp:* ●—●
John was angry *State, Simp:* ●—●, ●—○	oi mi f >	o m fi <	″	Mary was happy *State, Simp:* ●—●, ●—○

The corresponding temporal relation table for the Past/Past tense combination is given here, where closed intervals are referred to as **C**, open intervals are referred to as **O**, and point-intervals are referred to as **P**.

Matrix/Adjunct	AFTER	BEFORE	WHILE
C/C	$>$	$<$	= o oi s d f
C/O	oi mi f $>$	o m fi $<$	= o oi s d f
C/P	$>$	$<$	= o oi s d f
O/C	$>$	$<$	= o oi s d f
O/O	oi mi f $>$	o m fi $<$	= o oi s d f
O/P	$>$	$<$	= o oi s d f
P/C	$>$	$<$	= s d f
P/O	oi m f $>$	o m fi $<$	= s d f
P/P	$>$	$<$	= s d f fi

4.2 Analysis Chart and Temporal Relation Table for the Future/Present BTS Combination

This section includes an analysis chart and temporal relation table for the Future/Present BTS combination for *after*, *before*, and *while*, e.g., *She will win the race while John writes a letter*.

Matrix	AFTER	BEFORE	WHILE	Adjunct
Mary will be winning the race *Ach, Prog:* •—•	oi f >	o fi <	= o s d f	John is writing a letter *Acc, Prog:* •—•
Mary will be winning the race *Ach, Prog:* •—•	″	″	″	John is winking *Act(pt), Prog:* •—•, •—○
John will be winking *Act(pt), Prog:* •—•, •—○	″	″	″	Mary is winning the race *Ach, Prog:* •—•
John will be winking *Act(pt), Prog:* •—•, •—○	″	″	″	Mary is walking *Act(ext), Prog:* •—•, •—○
Mary will be winning the race *Ach, Prog:* •—•	>	<	= oi s d f	John writes a letter *Acc, Simp:* •
Mary will be winning the race *Ach, Prog:* •—•	″	″	″	John winks *Act(pt), Simp:* •
John will be winking *Act(pt), Prog:* •—•, •—○	″	″	″	Mary wins the race *Ach, Simp:* •
John will be winking *Act(pt), Prog:* •—•, •—○	oi f >	o fi <	= o s d f	Mary walks *Act(ext), Simp:* •—•
Mary will be winning the race *Ach, Prog:* •—•	″	″	″	John is angry *State, Simp:* •—•, •—○
Mary will be winking *Act(pt), Prog:* •—•, •—○	″	″	″	John is angry *State, Simp:* •—•, •—○
Mary will win the race *Ach, Simp:* •	oi f >	<	= o oi s si d	John is writing a letter *Acc, Prog:* •—•
Mary will win the race *Ach, Simp:* •	″	″	″	John is winking *Act(pt), Prog:* •—•, •—○
John will wink *Act(pt), Simp:* •	″	″	″	Mary is winning the race *Ach, Prog:* •—•
John will wink *Act(pt), Simp:* •	″	″	″	Mary is walking *Act(ext), Prog:* •—•, •—○
Mary will win the race *Ach, Simp:* •	>	<	= o oi s si d	John writes a letter *Acc, Simp:* •
Mary will win the race *Ach, Simp:* •	″	″	″	John winks *Act(pt), Simp:* •
John will wink *Act(pt), Simp:* •	″	″	″	Mary wins the race *Ach, Simp:* •
John will wink *Act(pt), Simp:* •	oi f >	<	= o oi s si d	Mary walks *Act(ext), Simp:* •—•
Mary will win the race *Ach, Simp:* •	″	″	″	John is angry *State, Simp:* •—•, •—○
Mary will wink *Act(pt), Simp:* •	″	″	″	John is angry *State, Simp:* •—•, •—○
John will be angry *State, Simp:* •—•, •—○	oi f >	o fi <	= o s d f	Mary is winning the race *Ach, Prog:* •—•
John will be angry *State, Simp:* •—•, •—○	″	″	″	Mary is walking *Act(ext), Prog:* •—•, •—○
John will be angry *State, Simp:* •—•, •—○	″	″	= oi s d f	Mary wins the race *Ach, Simp:* •
John will be angry *State, Simp:* •—•, •—○	″	″	= o s d f	Mary walks *Act(ext), Simp:* •—•
John will be angry *State, Simp:* •—•, •—○	″	″	″	Mary is happy *State, Simp:* •—•

The corresponding temporal relation table for the Future/Present tense combination is given here, where closed intervals are referred to as **C**, open intervals are referred to as **O**, and point-intervals are referred to as **P**.

Matrix/Adjunct	AFTER	BEFORE	WHILE
C/C	f oi >	o fi <	= o s d f
C/O	f oi >	o fi <	= o s d f
C/P	>	<	= oi s d f
O/C	f oi >	o fi <	= o s d f
O/O	f oi >	o fi <	= o s d f
O/P	>	<	= oi s d f
P/C	f oi >	<	= o oi s si d
P/O	f oi >	<	= o oi s si d
P/P	>	<	= o oi s si d

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